Aerial Ships. By Russell Thayer, C.E.

(Read before the American Philosophical Society, Nov. 16, 1883.)

At the close of an interesting paper on the subject of aerial navigation, read before the Institution of Civil Engineers, by Mr. William Pole, F.R.S. M. Inst. C. E., the following conclusions are stated, viz.:

"The problem of aerial navigation by balloons is one as perfectly amenable to mechanical investigation as that of aquatic navigation by floating vessels; and its successful solution involves nothing unreasonable or inconsistent with the teachings of mechanical science.

"It has been fully established by experiment that it is possible to design and construct a balloon which shall possess the conditions necessary for aerial navigation, *i.e.*, which shall have a form of small resistance, shall be stable and easy to manage, and, if driven through the air, shall be capable of steering by a proper obedience to the rudder.

"If, by a power carried with the balloon, surfaces of sufficient area can be made to act against the surrounding air, the reaction will propel the balloon through the air in an opposite direction.

"The modern invention of the screw-propeller furnishes a means of applying power in this way, to effect the propulsion; and the suitability and efficacy of such means have been shown by actual trial.

"Sufficient data exists to enable an approximate estimate to be made of the power necessary to propel such a balloon with any given velocity through the air.

"The recent great reduction in the weight of steam motors has rendered it possible to carry with the balloon an amount of power sufficient to produce moderately high speed, say twenty or thirty miles an hour through the air; and by taking advantage of other recent improvements it would also be possible to carry a moderate supply of fuel and water for the working.

"The practical difficulties in the way are only such as naturally arise in the extension of former successful trials, and such as may reasonably be expected to give way before skill and experience."

In the discussion of the question, Mr. Pole considered the propeller as being the only known available means of utilizing the force generated for the propulsion of the aerial ship; and the deductions above quoted are based upon this means being used to apply the force. My investigations and experiments, however, have induced me to believe that for the purpose desired the propeller is a most clumsy and unsuitable contrivance; indeed, the immense size that would be required for the propulsion of even aerial ships of ordinary dimensions renders its use impracticable.

For the past year I have been making somewhat of a study of this subject, with the object in view of ascertaining whether any practicable method of propulsion could be devised which would enable an aerial ship properly constructed to have a rapid motion through the air, in any direction, entirely independent of the atmosphere or medium in which it floats.

An investigation of the methods heretofore devised to accomplish this object, viz., wheels, propellers, wings, etc., convinced me that all plans so far suggested are quite impracticable; and my experiments led me to the following discovery, based on the well-known law of mechanics that "action and re-action are always equal, contrary and simultaneous."

My invention is simply to make use of the reactive force of a powerful jet of air, gas or vapor, acting rearwards under pressure; thus producing* a re-action forward equal in every respect to the pressure backwards. Under these circumstances the aerial ship will be forced forward at rates of speed depending upon the amount of pressure applied, and it is surprising to note the small pressure required to send a structure of considerable size through the atmosphere at rates of speed varying from ten to fifty miles an hour, without the assistance of the wind, which, under some circumstances, could be most beneficially employed in generating very high rates of motion.

For the following formulæ and values of co-efficients below mentioned, I am indebted to Mr. Pole's paper above referred to; and I have condensed my ideas on the subject in the following memorandum of notes, giving all the salient points of the problem:

Shape.

d = diameter midship section.

e = length of axis.

Shape, cylindrical, pointed at both ends (fore and aft), the best form wherein e = $3\frac{3}{4}$d.

Ascending Force of Gas.

Ad^2l, in which A is a co-efficient, depending on the shape of the vessel and on the specific quantity of the gas compared with that of the surrounding air, may be taken = .03.

The levity of 1 cu. ft. of hydrogen = .0751 lb.

Resistance to Motion through the Air.

$x = .000193\ d^2\ v^2$, in which v = velocity in feet per second. The resistance varies as the square of v.

Propelling Force.

The propelling force should act in a horizontal line with all the resistances, which would be a little below the line of the axis (Pole). This force would be produced by air, gas or vapor, acting sternwards under pressure; preferably compressed air, forced through a nozzle suitably connected with a high speed air-compressor.

Machinery Required.

Boiler, steam-engine, air-compressor (receiver), outlet-pipe with nozzle steam condenser, with chemical refrigerating mixture.

* Genl. Thayer has taken out patents for this invention.

To Raise and Lower Ship without using Ballast.

Use an interior air-vessel connected with air-pump, the exterior balloon being connected with a strong light receiver containing hydrogen gas under high pressure. To lower ship, pump air into interior sack and remove hydrogen from exterior balloon. To ascend, remove the air from the interior sack and allow hydrogen to flow into balloon under pressure from receiver; the hydrogen in the receiver would also be utilized to supply loss from leakage.

To Steer Ship.

Use rudder and also a movable nozzle, through which the force of propulsion is applied.

To Elevate or Depress Bow.

Shift ballast or elevate or depress nozzle.

Miscellaneous Data.

In landing, turn the head of the aerial ship to the wind, thus avoiding all danger from dragging, etc. In navigating, it is only necessary to go high enough to clear terrestrial objects.

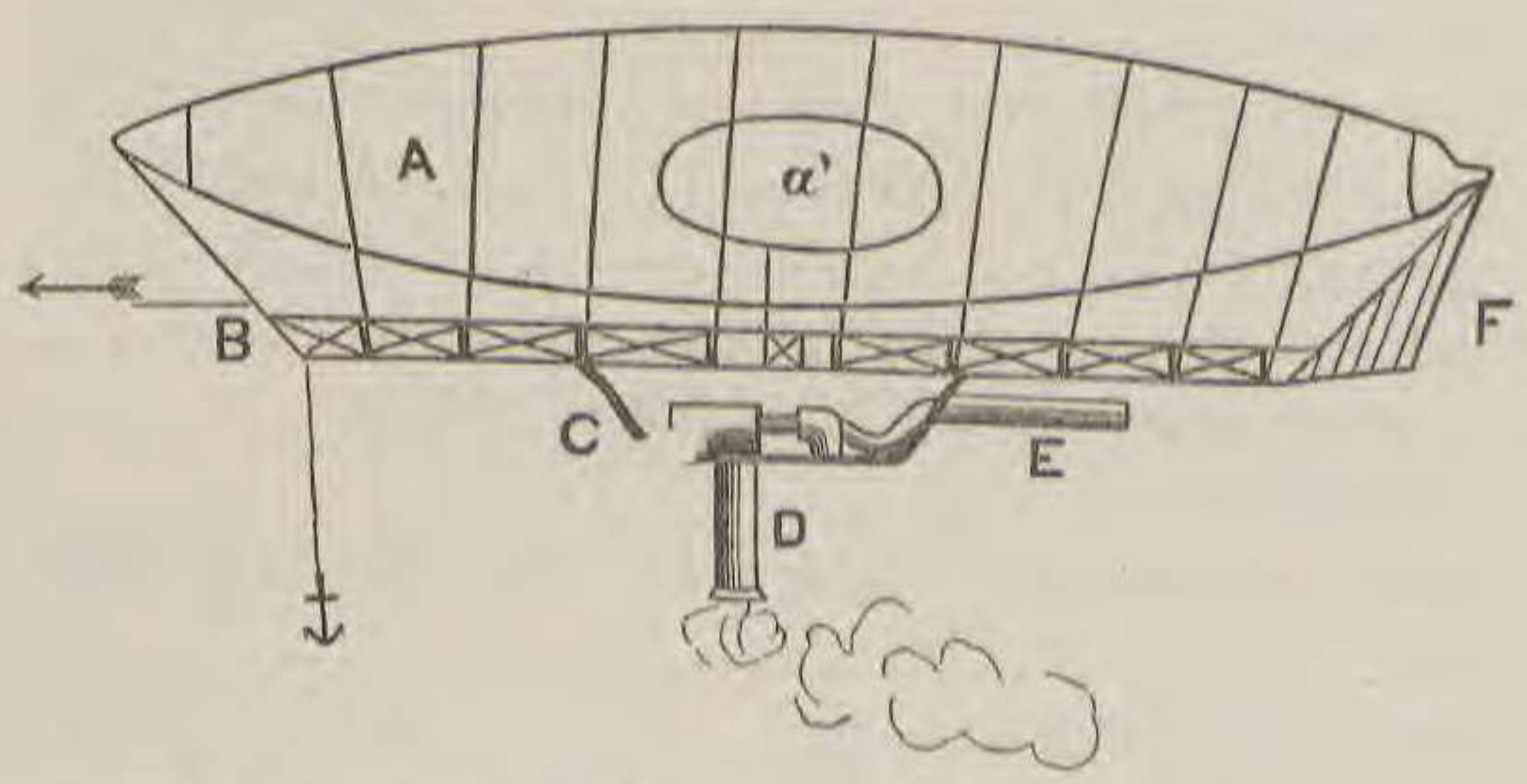
Weight of motor, 40 lbs. per H. P., loss about 15 per cent.

Fuel, 4 lbs. per indicated H. P. per hour.

Water, 28 lbs. per H. P. (condense the steam).

Giffard made envelopes successfully to contain gas with scarcely any loss.

In conclusion, I would say that the general appearance of the aerial ship would be as follows, viz. :



A, balloon ; B, upper deck ; C, lower deck for machinery ; D, smoke-stack ; E, nozzle ; F, rudder ; a′, interior air-sack.

Example.

$\left.\begin{array}{l} d = 30' \\ l = 110' \end{array}\right\}$ Total ascending force $Ad^2l = 2970$ lbs.

Resistance to passing through the air at a speed of twenty miles an hour = 29.33 lin. feet per sec., $000193\ d^2\ v^2 = 149.5$ lbs.,

a force that can readily be obtained and applied, as I have suggested.